Descending Systems Translate Transient Cortical Commands into a Sustained Muscle Activation Signal.

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Abstract:

Controlling motor actions requires online adjustments of time-varying parameters. Although numerous studies have attempted to identify the parameters coded in different motor sites, the relationships between the temporal profile of neuronal responses and the dynamics of motor behavior remain poorly understood in particular because motor parameters such as force and movement direction often change over time. We studied time-dependent coding of cortical and spinal neurons in primates performing an isometric wrist task with an active hold period, which made it possible to segregate motor behavior into its phasic and sustained components. Here, we show that cortical neurons transiently code motor-related parameters when actively acquiring a goal, whereas spinal interneurons provide persistent information regarding maintained torque level and posture. Moreover, motor cortical neurons differed substantially from spinal neurons with regard to the evolution of parameter-specific coding over the course of a trial. These results suggest that the motor cortex and spinal cord use different control policies: Cortical neurons produce transient motor commands governing ensuing actions, whereas spinal neurons exhibit sustained coding of ongoing motor states. Hence, motor structures downstream to M1 need to integrate cortical commands to produce state-dependent spinal firing.

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